3 Quality Assurance Procedures

Design Mix Formula

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Mixture Acceptance

QC/QA HMA
HMA

Pay Factors -- QC/QA HMA (Dense Graded Mixture ≥ 1 Lot)

PWL - Mixture
PWL – Density
Pay Factors

Adjustment Quantity -- QC/QA HMA ≥ 1 Lot

Pay Factors -- QC/QA HMA (Dense Graded Mixture < 1 Lot and Open Graded Mixtures)

Mixture
Density

Adjustment Quantity -- QC/QA HMA < 1 Lot and Open Graded Mixures

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Smoothness

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Profilograph Exemptions
Quality Assurance Adjustments

CHAPTER THREE:
QUALITY ASSURANCE PROCEDURES

The acceptance criteria for QC/QA HMA set out in the Quality Assurance Specifications are based on binder content, air voids @ N_{des}, VMA @ N_{des}, density and smoothness. The Specifications establish controls for temperature of the mixture, testing of aggregates for quality, and testing of binder. The acceptance criteria for HMA mixtures are based on binder content and air voids. The acceptance criteria for SMA mixtures are binder content and gradation.

This section includes the procedures for obtaining acceptance samples, minimum requirements for mixture properties in accordance with Sections **401** (QC/QA HMA)**,** and **402** (HMA) and the procedures for determining pay factors.

DESIGN MIX FORMULA

The Contractor is required to submit for the Engineer's approval a Design Mix Formula (DMF) for each mixture. This information is recorded in a format acceptable to the Engineer. TD-451 is one format that has been used for this purpose (Figure 3-1). INDOT is required to have a signed copy of the DMF prior to production of any mixture.

LOT/SUBLOT – QC/QA HMA and SMA

Quality Assurance Specifications consider a lot as 5000 t of Base or Intermediate QC/QA HMA, and 3000 t of Surface QC/QA HMA or SMA. The lots are divided into five sublots of equal tons. For Base and Intermediate QC/QA HMA therefore, a sublot is 1000 t, and for Surface QC/QA HMA or SMA, a sublot is 600 t. Partial sublots of 100 t or less are added to the previous sublot. Partial sublots greater than 100 t constitute a full sublot. Partial lots of four sublots or less are added to the previous lot, if applicable.

INDIANA DEPARTMENT OF TRANSPORTATION
MATERIALS AND TESTS DIVISION
HMA DMF/JMF per 401/402

HMA PRODUCER :	
PLANT LOCATION :	
CERTIFIED PLANT NUMBER:	
APPROVED DESIGN LAB :	

Aggregate Size	Source	Source #	Q-Number	Ledges	%	Dolo. Test (YES/NO)?	Sample Per ___ Tons of HMA

PG BINDER	Source	Source #		Binder % RAS	Binder Replacement %	Virgin Binder %
				0.0%	0.0%	0.0%
Additives/ Fibers/ Etc.	Source	Source #				%

DMF number		**101999**			Fine RAP/ Coarse RAP/ RAS in mixture, %	
					Fine RAP/ Coarse RAP/ RAS binder, extracted, %	
Comments:					Ignition oven test temp (°F)	
					Ignition oven calibration factor	
					Ignition oven number	
Base Design PG-Grade					Binder, ignition (actual), %	
Mixture course					Binder, extracted, %	
Mixture designation					Extraction required? Yes* or No	
Maximum particle size		#N/A			Binder, calculated effective, %	
	Spec	DMF Mass	JMF Mass	Volume	Gyrations Nini / Ndes / Nmax	
%Pass 37.5 mm					Mass gyratory pill @ Ndes, g	
%Pass 25.0 mm					Gmm	
%Pass 19.0 mm					Gmm w/ dry back? Yes or No	
%Pass 12.5 mm					Gmm % @ Nini and Nmax	
%Pass 9.5 mm					Gmb @ Ndes	
%Pass 4.75 mm					Air Voids @ Ndes, %	
%Pass 2.36 mm					VMA @ Ndes, %	
%Pass 1.18 mm					VFA @ Ndes, %	
% Pass 600 µm					Coarse agg. ang. 1 & 2 face, %	
% Pass 300 µm					Fine aggregate angularity	
% Pass 150 µm					Sand equivalency	
% Pass 75 µm					Dust/calculated effective binder	
Aggregate blend Gsb					Tensile strength ratio, %	
WMA temp. plant min./max. (°F)					Draindown, % (SMA or OG only)	
HMA temp. plant min/max. .(°F)					Date Ignition oven samples submitted	
Mix compaction temp.lab (°F)					VCA_{DRC}/VCA_{MIX} (SMA only >1)	
* Extraction Note - Written request required, submit w / DMF					**MAF by DTE for PE/PS**	**1.000**

PRODUCER: ______________________________ DATE: ______________

DTE SIGNATURE: ______________________________ DATE: ______________

DTE Notes:
DMF reference history:
Producer Notes:

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Figure 3-1. Design Mix Formula

TYPES OF SAMPLES

PLATE SAMPLES

INDOT, if possible, requires samples to be obtained at the point-of-placement. For QC/QA HMA and SMA, that location is from the road. HMA samples are obtained from the road by using metal plates. One or more metal plates are positioned on the road before the mixture is placed. Once the paver paves over the plates, the plates are located and removed from the pavement before compaction. The mixture retained on the plates is placed in sample containers (Figure 3-2), marked, and shipped to an INDOT Production Lab for testing.

Figure 3-2. HMA Sample Container

TRUCK SAMPLES

Truck samples (Figure 3-3) are HMA samples taken directly from the truck before delivery to a contract. This type of sampling is often done by the Contractor at the plant to obtain information about the HMA quickly. INDOT may obtain a truck sample for HMA (402 mixture) for verification of the Specification requirements.

Figure 3-3. Truck Sample

CORE SAMPLES

Core samples (Figure 3-4) are taken from the compacted pavement usually to obtain the density of the QC/QA HMA and SMA mixtures. The Contractor is required to obtain these samples in the presence of an INDOT representative. These samples are then shipped to an INDOT Production lab for the appropriate testing.

Figure 3-4. Core Sample

APPEAL SAMPLES

Appeal samples are samples obtained for testing when the Contractor does not agree with the original acceptance sample test results. The Contractor submits an appeal in writing that includes test data that indicates a lesser penalty than would be assessed from the original acceptance tests. Once approved by the District Testing Engineer, appeal samples are tested. For QC/QA HMA, the appeal samples are obtained at the same time as the acceptance plate samples. For SMA, the appeal samples are cores taken after the appeal has been granted.

METHODS OF ACCEPTANCE SAMPLING

The first step in acceptance sampling is determining when and where to take the sample. This process is done randomly so that all of the mixture has a chance to be sampled and so there is no bias in obtaining the sample.

RANDOM NUMBERS

Sampling for mixture tests is done on a random basis using **ITM 802**. A table of Random Numbers, as shown in Figure 3-5, is used to determine the random quantity or random location. The numbers occur in this table without aim or reason and are in no particular sequence. Therefore, samples obtained by the use of this table are truly random or chance, and eliminate any bias in obtaining samples.

To use the random number table to determine the random ton to sample, select without looking one block in the table. After selecting the block, the top left number in the block is the first random number used. This number is the beginning number. Proceed down the column for additional numbers and proceed to the top of the next column on the right when the bottom of the column is reached. When the bottom of the last column on the right is reached, proceed to the top of the column at the left. If all numbers in the table are used, select a new starting number and proceed in the same manner.

To use this table to determine the location of the pavement sample, again select a block in the table and start with the top left number. This number is used to determine the test site station. The adjacent number within the block is used to determine the transverse distance to the random site. Proceed down by pairs until the bottom numbers are reached and proceed to the adjacent top block to the right, if available. When the bottom pair of numbers on the right are reached, proceed to the top block on the left in the table.

0.576	0.730	0.430	0.754	0.271	0.870	0.732	0.721	0.998	0.239
0.892	0.948	0.858	0.025	0.935	0.114	0.153	0.508	0.749	0.291
0.669	0.726	0.501	0.402	0.231	0.505	0.009	0.420	0.517	0.858
0.609	0.482	0.809	0.140	0.396	0.025	0.937	0.310	0.253	0.761
0.971	0.824	0.902	0.470	0.997	0.392	0.892	0.957	0.040	0.463
0.053	0.899	0.554	0.627	0.427	0.760	0.470	0.040	0.904	0.993
0.810	0.159	0.225	0.163	0.549	0.405	0.285	0.542	0.231	0.919
0.081	0.277	0.035	0.039	0.860	0.507	0.081	0.538	0.986	0.501
0.982	0.468	0.334	0.921	0.690	0.806	0.879	0.414	0.106	0.031
0.095	0.801	0.576	0.417	0.251	0.884	0.522	0.235	0.389	0.222
0.509	0.025	0.794	0.850	0.917	0.887	0.751	0.608	0.698	0.683
0.371	0.059	0.164	0.838	0.289	0.169	0.569	0.977	0.796	0.996
0.165	0.996	0.356	0.375	0.654	0.979	0.815	0.592	0.348	0.743
0.477	0.535	0.137	0.155	0.767	0.187	0.579	0.787	0.358	0.595
0.788	0.101	0.434	0.638	0.021	0.894	0.324	0.871	0.698	0.539
0.566	0.815	0.622	0.548	0.947	0.169	0.817	0.472	0.864	0.466
0.901	0.342	0.873	0.964	0.942	0.985	0.123	0.086	0.335	0.212
0.470	0.682	0.412	0.064	0.150	0.962	0.925	0.355	0.909	0.019
0.068	0.242	0.777	0.356	0.195	0.313	0.396	0.460	0.740	0.247
0.874	0.420	0.127	0.284	0.448	0.215	0.833	0.652	0.701	0.326
0.897	0.877	0.209	0.862	0.428	0.117	0.100	0.259	0.425	0.284
0.876	0.969	0.109	0.843	0.759	0.239	0.890	0.317	0.428	0.802
0.190	0.696	0.757	0.283	0.777	0.491	0.523	0.665	0.919	0.246
0.341	0.688	0.587	0.908	0.865	0.333	0.928	0.404	0.892	0.696
0.846	0.355	0.831	0.218	0.945	0.364	0.673	0.305	0.195	0.887
0.882	0.227	0.552	0.077	0.454	0.731	0.716	0.265	0.058	0.075
0.464	0.658	0.629	0.269	0.069	0.998	0.917	0.217	0.220	0.659
0.123	0.791	0.503	0.447	0.659	0.463	0.994	0.307	0.631	0.422
0.116	0.120	0.721	0.137	0.263	0.176	0.798	0.879	0.432	0.391
0.836	0.206	0.914	0.574	0.870	0.390	0.104	0.755	0.082	0.939
0.636	0.195	0.614	0.486	0.629	0.663	0.619	0.007	0.296	0.456
0.630	0.673	0.665	0.666	0.399	0.592	0.441	0.649	0.270	0.612
0.804	0.112	0.331	0.606	0.551	0.928	0.830	0.841	0.702	0.183
0.360	0.193	0.181	0.399	0.564	0.772	0.890	0.062	0.919	0.875
0.183	0.651	0.157	0.150	0.800	0.875	0.205	0.446	0.648	0.685

Figure 3-5. Random Numbers

PLATE SAMPLES

A specific ton in each sublot is selected and the mixture from the truck containing that ton is sampled. This truck is determined by checking the weigh tickets. An example of how to determine what ton is to be sampled is indicated on form TD 452 (Figure 3-6). These random tons are not shown to the Contractor so that there is no possible influence on the construction operations.

Once the truck that contains the random ton is identified, the approximate total length of mixture that the truck places is determined by knowing the weight of the truck, the paving width, and the quantity placed. When placing variable depth, such as a crown correction, the average depth is used. The following relationship is used to calculate this approximate length that a truck would place.

$$\underset{\text{(Nearest Foot)}}{\text{Length of Load}} = \frac{\text{Load Weight (t)}}{\underset{(\text{lb/yd}^2)}{\text{Avg. Planned Quantity}} \times \underset{\text{Paving (ft)}}{\text{Width of}}} \times 18000$$

The length the truck places is multiplied by the first random number to obtain a longitudinal distance. This distance is measured from the location of the paver when the truck containing the random ton begins unloading into the paver or material transfer device. The transverse test site location is determined by multiplying the width of pavement by the second random number and rounding to the nearest whole ft. This distance is measured from the right edge of pavement when looking in the direction of increasing station numbers. If the transverse location is less than 1 ft from either edge of pavement, at a location where the course thickness is less than 2.0 times the maximum particle size, or within the width of the roller drum used to form shoulder corrugations, then another random location is selected to obtain an acceptable sampling location. The first 300 t of the first sublot of the first lot for each DMF/JMF is not sampled. If the random ton selected for the sublot is within the first 300 t, then 300 is added to the random ton number and the sample is obtained from the truck containing that ton.

TD-452 State Form 36667 (R3/3-95)

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FILE

INDIANA DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS

RANDOM SAMPLING FOR MIX ANALYSIS

Contract No. R-20396 LOT No. 4

District Greenfield Mixture 19.0 mm Intermediate

DATE SAMPLED: SUBLOT 1 6/9/01 SUBLOT 2 6/9/01 SUBLOT 3 6/10/01 SUBLOT 4 6/10/01

SUBLOT NO.	SUBLOT TONS	RANDOM NO.	RANDOM TON	LOT TON TO BE SAMPLED		PAVING WIDTH	RANDOM NO.	TRANS. LOC.	LENGTH OF LOAD	RANDOM NO.	RANDOM DIST.	STARTING STA.*	RANDOM STATION
	A	B	A × B = C	D	C + D	E	F	E × F	G	H	G × H = I	J	I + J
1	600			0									N.B. Passing
	1000	.123	123	0	123	12	.100	1.2 (1)	136	.259	35	10+50	10+85
2	600			625									N.P. Passing
	1000	.116	116	1000	1116	12	.890	10.7 (11)	136	.317	43	76+90	77+33
3	600			1250									N.B. Passing
	1000	.836	836	2000	2836	12	.523	6.3 (6)	136	.665	90	194+00	194+90
4	600			1875									N.B. Passing
	1000	.636	636	3000	3636	12	.928	11.1 (11)	136	.404	55	247+20	247+75

* STATION OF PAVER WHEN TRUCK CONTAINING RANDOM TON BEGINS UNLOADING.

$$\text{Length of Load (Nearest Foot)} = \frac{\text{Load Weight (tons)}}{\text{Avg. Planned Quantity (lb./sq. yd.)} \times \text{Width of Paving (ft.)}} \times 18000$$

Figure 3-6. Random Sampling for Mix

The following example indicates how these random locations are determined.

Example:

Width of Pavement	=	12 ft
Load Weight	=	20 t
Mixture	=	9.5 mm Surface
Planned Quantity	=	110 lb/yd^2
Ending Station of Paver of Previous Load	=	158+00
Random Numbers	=	256, .561

Test Site Station

$$\text{Length of Load} = \frac{20}{110 \times 12} \times 18000 = 273 \text{ ft}$$

Longitudinal Distance = 273 x .256 = 70 ft

Random Station = (158+00) + 70 = 158+70

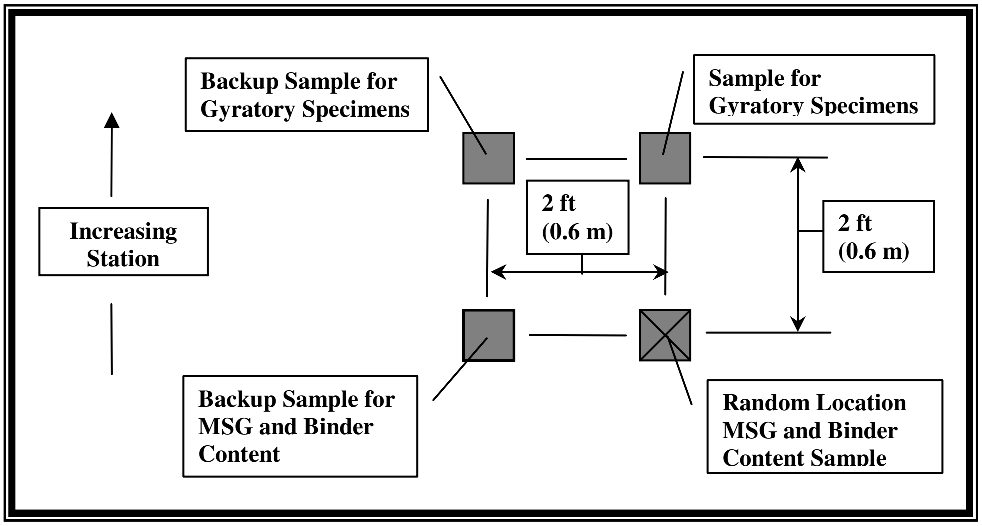
Transverse Distance

Distance = 12 x .561 = 6.7 ft (say 7 ft)

For contracts controlled by volumetrics for QC/QA HMA (**401**), several samples are required. The first plate sample location is determined by the random sampling procedure and this material is used for the maximum specific gravity and binder content samples. A second plate sample is placed longitudinally 2 ft upstation from the first plate at the same transverse offset. This sample is used for the gyratory specimens.

If an appeal by the Producer of the INDOT test results is accepted, backup samples are tested. These samples are obtained at the same time as the acceptance samples. The backup sample plate for the maximum specific gravity and binder content is placed transversely 2 ft from the first plate towards the center of the mat. The backup sample for the gyratory specimens is placed transversely 2 ft from the second plate towards the center of the mat.

The following diagram indicates an example of an arrangement of the plate samples when additional samples are required for QC/QA HMA:



An example of determining the sample locations is as follows:

Example:

Width of Pavement	= 12 ft
Load Weight	= 20 t
Mixture	= 9.5 mm Surface
Planned Quantity	= 110 lb/yd^2
Ending Station of Paver of Previous Load	= 158+00
Random Numbers	= 256, .561

Test Site Station

$$\text{Length of Load} = \frac{20}{110 \times 12} \times 18000 = 273 \text{ ft}$$

Longitudinal Distance = 273 x .256 = 70 ft

Random Station = (158+00) + 70 = 158+70

Transverse Distance

Distance = 12 x .561 = 6.7 ft (say 7 ft)

MSG and Binder Content Sample

Random Location = 158 + 70
Transverse Distance = 7 ft

Gyratory Specimens Sample

Random Location = (158 + 70) + 02
= 158 + 72

Transverse Location = 7 ft

Backup Sample for MSG and Binder Content

Random Location = 158 + 70
Transverse Distance = 7-2
= 5 ft

Backup Sample for Gyratory Specimens

Random Location = (158 + 70) + 2
= 158 + 72
Transverse Distance = 7-2
= 5 ft

The procedure for obtaining plate samples (Figure 3-7) once the random location is determined is as follows:

1) A clean metal plate with attached wire is placed on the pavement. Should conditions on the contract require stabilizing movement to avoid slipping of the plate, a nail is driven into the pavement, and the plate hole placed onto the nail. A No. 18 gage mechanics wire and masonry nail has been proven to be effective for this purpose.

2) The wire is extended beyond the edge of the paving width. The wire should not pass under a grade leveler attached to the paver. Trucks, pavers, or material transfer devices are allowed to cross the plate and/or wire. If a windrow elevator is used, the paving operation is stopped so that the plate may be placed between the windrow elevator and the paver.

3) After the mixture is placed and before any compaction from the rollers occurs, the wire is used to locate the plate.

4) The plate is lifted with the wire, a narrow shovel or pitchfork is inserted under the plate, and the plate is lifted from the pavement.

5) The sample is then placed in a container for transport to the testing facility. Material remaining on the plate is required to be removed and replaced into the sample container.

Figure 3-7. Plate Sampling

If the depth of the mixture is such that the material may fall off the sides of the plate when lifted from the pavement, a mold may be used with the plate. Only the plate or the plate with a mold procedures are allowed foe the acceptance sample. The placement and location of the plate are done using the same procedures and restrictions used for sampling when only a plate is used. Additional requirements for using a mold with a plate include:

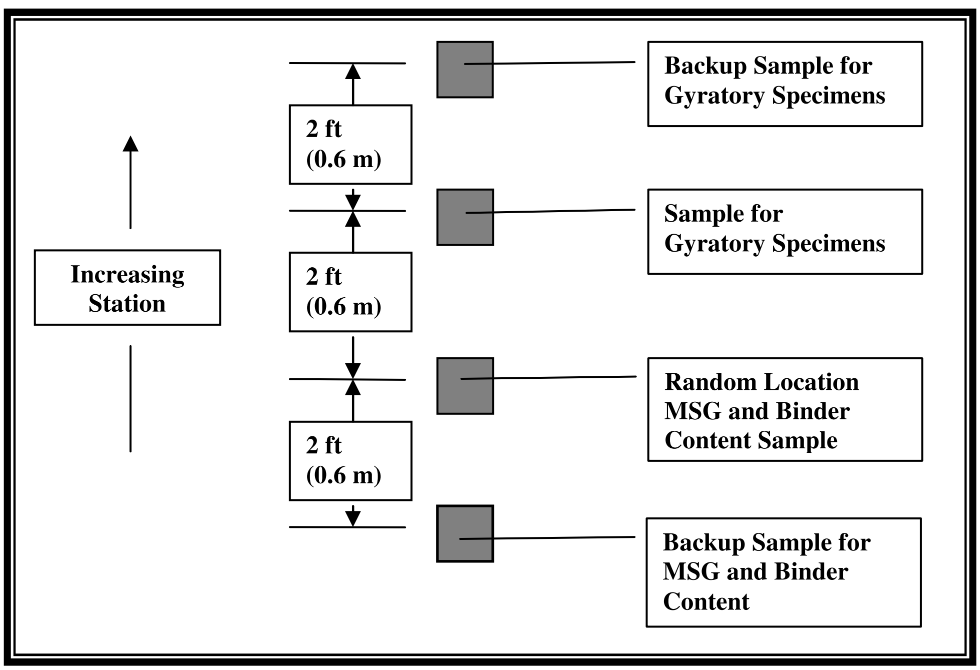
1) A clean round mold, with a height greater than the mixture thickness and diameter less than the width of the plate, is pushed by means of a circular motion into the mixture directly over the plate.

2) The mold and plate are raised together and a pitchfork or narrow shovel is inserted under the plate.

3) The mold and plate are lifted from the pavement and any excess mixture on top of the plate and outside of the mold is discarded.

4) The sample inside the mold is placed into the sample container. Material remaining on the plate is removed and placed into the sample container.

When the pavement width is 4 ft or less, the samples are obtained from the center of the course and at least 1 ft from the edge of the course. The backup sample plate for the maximum specific gravity and binder content is placed 2 ft back station from the first plate in the center of the course. The backup sample for the gyratory specimens is placed 2 ft ahead station from the second plate in the center of the course. The following diagram indicates an example of an arrangement of the plate samples when additional samples are required for QC/QA HMA and the width of the pavement course is 4ft or less:



Example:

Width of Pavement = 4 ft
Load Weight = 20 t
Mixture = 9.5 mm Surface
Planned Quantity = 110 lb/yd^2
Ending Station of Paver
of Previous Load = 158+00
Random Numbers = .256, .561

Test Site Station

Length of Load = $\frac{20}{110 \times 4}$ x 18000 = 818 ft

Longitudinal Distance = 818 x .256 = 209 ft

Random Station = (158+00) + 209 = 160+09

Transverse Distance

Distance = 4/2 = 2 ft

MSG and Binder Content Sample

Random Location = 160 + 09
Transverse Distance = 2 ft

Gyratory Specimens Sample

Random Location = (160 + 09) + 2 ft
= 160 + 11
Transverse Distance = 2 ft

Backup Sample for MSG and Binder Content

Random Location = (160 + 09) – 02
= 160 + 07
Transverse Distance = 2 ft

Backup Sample for Gyratory Specimens

Random Location = (160 + 11) + 2 ft
= 160 + 13
Transverse Distance = 2 ft

The size of the plate used to obtain a sample is dependent on the test(s) conducted on the material. The following minimum sample weights are required:

Mixture Designation	Minimum Weights (g)	
	MSG and Binder Content	Gyratory Specimens
4.75 mm	1200	11000
9.5 mm	3000	11000
12.5 mm	4000	11000
19.0 mm, OG 19.0 mm	5500	11000
25.0 mm, OG 25.0 mm	7000	11000

Figure 3-8 indicates the approximate weights that may be obtained for various sizes of plates and lift thicknesses that are placed.

Figure 3-9 indicates the approximate weights that may be obtained for various sizes of molds and lift thicknesses when a mold is used with the plate for obtaining a sample.

Approximate Sample Yield for Various Lift Thickness and Plate Sizes								
Lift Thickness (inches)	**Lay Rate (lb/syd)**	**Plate Size, inches**						
		8	**9**	**10**	**11**	**12**	**14**	**16**
		Sample Weight (g)						
1.25	137.5	3100	3900	4800	5900	7000	9500	12400
1.5	165	3700	4700	5800	7000	8400	11400	14900
1.75	192.5	4300	5500	6800	8200	9800	13300	17300
2.0	220	5000	6300	7700	9400	11100	15200	19800
2.25	247.5	5600	7100	8700	10500	12500	17100	22300
2.5	275	6200	7800	9700	11700	13900	19000	27800
2.75	302.5	6800	8600	10600	12900	15300	20900	27300
3.0	330	7400	9400	11600	14100	16700	22800	29700
3.25	357.5	8100	10200	12600	15200	18100	24700	32200
3.5	385	8700	11000	13500	16400	19500	26600	34700
3.75	412.5	9300	11800	14500	17600	20900	28500	37200
4.0	440	9900	12500	15500	18700	22300	30300	39600
4.25	467.5	10500	13300	16400	19800	23600	32100	41900
4.5	495	11100	14000	17300	21000	25000	34000	44400
4.75	522.5	11700	14800	18300	22100	26400	35900	46900
5.0	550	12300	15600	19300	23300	27700	37800	49300
5.25	577.5	12900	16400	20200	24500	29100	39700	51800
5.5	605	13600	17200	21200	25600	30500	41500	54300
5.75	632.5	14200	17900	22200	26800	31900	43400	56700
6.0	660	14800	18700	23100	28000	33300	45300	59200

Figure 3-8. Approximate Sample Yield for Various Lift Thickness and Plate Sizes

Approximate Sample Yield for Various Lift Thicknesses and Mold Sizes						
Lift Thickness (inches)	**Lay Rate (lb/yd²)**	**Mold Size, inches**				
		8	**10**	**12**	**14**	**16**
		Sample Weight (g)				
1.25	137.5	2400	3800	5400	7400	9700
1.5	165	2900	4500	6500	8900	11600
1.75	192.5	3400	5300	7600	10400	13600
2.0	220	3900	6100	8700	11900	15500
2.25	247.5	4400	6800	9800	13300	17400
2.5	275	4800	7600	10900	14800	19400
2.75	302.5	5300	8300	12000	16300	21300
3.0	330	5800	9100	13100	17800	23200
3.25	357.5	6300	9800	14200	19300	25200
3.5	385	6800	10600	15300	20800	27100
3.75	412.5	7300	11300	16300	22200	29100
4.0	440	7700	12100	17400	23700	31000
4.25	467.5	8200	12900	18500	25200	32900
4.5	495	8700	13600	19600	26700	34900
4.75	522.5	9200	14400	20700	28200	36800
5.0	550	9700	15100	21800	29700	38700
5.25	577.5	10200	15900	22900	31100	40700
5.5	605	10700	16600	24000	32600	42600
5.75	632.5	11100	17400	25100	34100	44500
6.0	660	11600	18200	26100	35600	46500

Figure 3-9. Approximate Sample Yield for Various Lift Thicknesses and Mold Sizes

TRUCK SAMPLING

Truck sampling is conducted at the HMA Plant by taking a sample directly from a truck hauling the mixture to the contract. The random ton is determined in accordance with **ITM 802**. The truck containing that ton is then sampled. Generally, truck sampling is done by the Producer for Quality Control purposes. Truck sampling is conducted in accordance with **ITM 580.**

CORE SAMPLING

Core sampling (Figure 3-10) is done by the Conractor under the supervision of an INDOT Technician. For QC/QA HMA, two cores are obtained in each sublot for density of the mixture. The core locations are determined by **ITM 802** with each core located independently within the sublot. All core sampling is done in accordance with **ITM 580**.

A 6 in diameter core is obtained from the pavement. The sample is removed from the pavement with a device that does not damage the layer to be tested. The layer to be tested is marked with a lumber crayon or permanent marker.

Figure 3-10. HMA Coring

ADJUSTMENT PERIOD -- QC/QA HMA

The Producer is allowed an adjustment period for each mix design in which the mix design is verified and changes may be made in the DMF, if necessary. A job mix formula (JMF) is submitted for approval to the Engineer one working day after the Producer receives the test results for the binder content, VMA, and air content. The adjustment period is from the beginning of production and extending until 5000 t of base or intermediate QC/QA HMA, or 3000 t of surface QC/QA HMA has been produced for each mix design. A reduced adjustment period is allowed. If production extends into the next construction season, another adjustment period is allowed.

MIXTURE ACCEPTANCE

QC/QA HMA

Acceptance of QC/QA HMA mixtures in accordance with **401** for binder content, VMA at N_{des}, and air voids at N_{des} for each lot is based on tests conducted by INDOT. INDOT randomly selects the location(s) within each sublot for sampling in accordance with the **ITM 802.** Samples from the pavement are obtained from each sublot in accordance with **ITM 580**.

A binder draindown test in accordance with **AASHTO T 305** for open graded mixtures is required once per lot and may not exceed 0.50 %.

The acceptance test results for each sublot are available after the sublot and the testing are complete.

HMA

Acceptance of HMA mixtures in accordance with **402** is done on the basis of a Type D certification submitted by the Producer to the Project Engineer on a contract. An example of this form is shown in Figure 3-11. The certification is required to be submitted with the first truck of each type of mixture each day. If no test results are available, the Producer indicates on the form that test results are required to be obtained within the first 250 tons and each subsequent 1000 tons for base and intermediate mixtures, and the first 250 tons and each subsequent 600 tons for surface mixtures. A DMF developed for a QC/QA HMA mixture in accordance with **401** may be used for **402** mixtures and the source or grade of the binder may be changed; however, the high temperature grade of the binder is required to be in accordance with **402.**

Mixtures in **402** that require the Type D Certification include miscellaneous HMA mixtures such as patching, widening, rumble strips, wedge and leveling, approaches, temporary mixtures, etc. In general these mixtures have low quantities and are placed in locations that plate samples cannot be obtained and the random sampling procedures are not applicable. On low traffic volume projects, mainline mixtures may also be included as mixtures accepted by Type D Certifications.

INDIANA DEPARTMENT OF TRANSPORTATION
HOT MIX ASPHALT (HMA) CERTIFICATION

CONTRACT NUMBER ____RS-30000_________ DATE__5/3/07______

CERTIFIED HMA PRODUCER ______J. Wooden Construction___________________________

CERTIFIED HMA PLANT NUMBER ____3550___ DMF/JMF NUMBER ___0310075___

PG BINDER SOURCE _____7199_____ PG BINDER GRADE ____PG 64-22_____________

MIXTURE TYPE AND SIZE ______HMA Surface, 9.5 mm, Type A________________________

DESIGN ESAL _____200,000_______

Air Voids __4.0__ (from DMF/JMF) Binder Content ___5.5__ (from DMF/JMF)

This is to certify that the test results for Air Voids and Binder Content represent the HMA mixture supplied to this contract.

Air Voids __4.3_ (± 1.5 % from DMF/JMF) Binder Content __5.7_ (± 0.7 % from DMF/JMF)

* [ ] Test results are not available for submittal. A production sample shall be taken within the first 250 t (250 Mg) and each subsequent 1000 t (1000 Mg) for base and intermediate mixtures and each subsequent 600 t (600 Mg) for surface mixtures.

* _✓_ If Applicable

____
Signature of HMA Producer Official

____
Title of Official

FOR PE/PS USE ONLY

PAY ITEM(S) ______________________________ BASIS FOR USE NO. C999998

SPECIFICATION REFERENCE

__ 304.04 - Patching	__ 402.07(c) - Temporary HMA	__ 610.02 - Approaches
__ 304.05 - Widening	__ 503.03(e) - Terminal Joints	__ 611.02 - Crossovers
__ 402.04 - HMA Pavements	__ 507.05(b) - Partial Depth Patching	__ 718.04 - Underdrains
__ 402.07(a) - Rumble Strips	__ 604.07(c) – Sidewalk	__ 801.11- Temp. Cross
__ 402.07(b) - Wedge & Leveling	__ 605.07(c) - Curbing	

Figure 3-11. HMA Certification

PAY FACTORS – QC/QA HMA (Dense Graded ≥ 1 Lot)

Pay factors for dense graded QC/QA HMA mixtures with original pay item quantities greater than or equal to one lot are determined in accordance with the procedures for Percent Within Limits (PWL) designated in **ITM 588**. The PWL method uses the average and standard deviation of the lot tests to estimate the percentage of the lot that is within the specification limits. The procedure for determining the PWL of the lot is as follows:

PWL - Mixture

1. Determine the average of the lot mixture properties for binder content, air voids at $N_{des,}$ and VMA at N_{des} as follows:

$$\bar{x} = \sum_{i=1}^{n} \frac{x_i}{n}$$

where:

$\bar{x}$ = average of the lot mixture property values
x_i = sublot mixture property value
n = number of mixture sublot samples in the lot

The binder content, air voids,, and VMA lot average values are reported to the nearest 0.01 %.

2. Determine the standard deviation of the lot mixture property as follows:

$$s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}$$

where:

s = standard deviation of the lot mixture property
x_i = sublot mixture property value
$\bar{x}$ = average of the lot mixture property values
n = number of mixture sublot samples in the lot

The standard deviation values for binder content, air voids, and VMA are reported to the nearest 0.01.

3. Calculate the Upper Quality Index for each mixture property by subtracting the lot average of each mixture property from the Upper Specification Limit (Figure 3-12) and dividing the result by the standard deviation of the lot mixture property as follows:

$$Q_U = \frac{USL - \bar{x}}{s}$$

where:

Q_u = Upper Quality Index
USL = Upper Specification Limit
$\bar{x}$ = average of the lot mixture property values
s = standard deviation of the lot mixture property

The binder content, air voids, and VMA Upper Quality Index values are reported to the nearest 0.01

SPECIFICATION LIMITS				
Mixture				
	LSL*		USL**	
Binder Content, %	- 0.40 from JMF		+ 0.40 from JMF	
Air Voids(Va) at N_{des}, %	2.60		5.40	
VMA at N_{des}, %	Greater Of		Lesser Of	
	Spec-0.50	JMF-1.20	Spec+2.00	JMF+1.20
Density				
	LSL		USL	
Roadway Core Density (%Gmm), %	91.00		Not Applicable	
* LSL, Lower Specification Limit ** USL, Upper Specification Limit				

Figure 3-12. Specification Limits

4. Calculate the Lower Quality Index for each mixture property by subtracting the Lower Specification Limit (Figure 3-12) from the lot average of each mixture property and dividing the result by the standard deviation of the lot mixture property as follows:

$$Q_L = \frac{\bar{x} - LSL}{s}$$

where:

Q_L = Lower Quality Index
LSL = Lower Specification Limit
$\bar{x}$ = average of the lot mixture property values
s = standard deviation of the lot mixture property

The binder content, air voids, and VMA Lower Quality Index values are reported to the nearest 0.01

5. Determine the percentage of material that will fall within the Upper and Lower Specification Limits (Figure 3-12) by entering the table of Quality Index Values (Figure 3-13) with Q_U or Q_L using the column appropriate to the total number of measurements, n.

6. Determine the percent of material that will fall within the limits for each mixture property by adding the percent within the Upper Specification Limit (PWL_U) to the percent within the Lower Specification Limit (PWL_L), and subtracting 100 from the total as follows:

$$\text{Total PWL} = (PWL_U + PWL_L) - 100$$

PWL - Density

1. Determine the average of the lot density values as follows:

$$\bar{x} = \sum_{i=1}^{n} \frac{x_i}{n}$$

where:

$\bar{x}$ = average of the lot density values
x_i = core density value
n = number of cores in the lot

The density (% Gmm) lot average value is reported to the nearest 0.01 %.

2. Determine the standard deviation of the lot density as follows:

$$s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}$$

where:

s = standard deviation of the density of the lot
$\bar{x}$ = average of the lot density values
x_i = core density value
n = number of cores in the lot

The standard deviation value is reported to the nearest 0.01.

3. Calculate the Lower Quality Index for in-place density (% G_{mm}) by subtracting the Lower Specification Limit (Figure 3-12) from the average of the density of the lot and dividing the result by the standard deviation of the density of the lot as follows:

$$Q_L = \frac{\bar{x} - LSL}{s}$$

where:

Q_L = Lower Quality Index
LSL = Lower Specification Limit
$\bar{x}$ = average of the lot density values
s = standard deviation of the density of the lot

The density Lower Quality Index value is reported to the nearest 0.01.

4. Determine the PWL for density by entering the table of Quality Index Values (Figure 3-13) using the column appropriate to the total number of measurements, n.

5. Determine the percent within the lower specification limit (PWL_L) for density as follows:

$$\text{Total PWL} = PWL_L$$

Quality Index (QI) Values PWL for a given sample size (n)												
QI	**n=3**	**n=4**	**n=5**	**n=6**	**n=7**	**n=8**	**n=9**	**n=10**	**n=11**	**n=12**	**n=13**	**n=14**
2.30	100	100	100	100	100	100	100	100	100	100	100	100
2.29	100	100	100	100	100	100	100	100	100	100	100	99
2.28	100	100	100	100	100	100	100	100	100	100	100	99
2.27	100	100	100	100	100	100	100	100	100	100	99	99
2.26	100	100	100	100	100	100	100	100	100	100	99	99
2.25	100	100	100	100	100	100	100	100	100	100	99	99
2.24	100	100	100	100	100	100	100	100	100	99	99	99
2.23	100	100	100	100	100	100	100	100	100	99	99	99
2.22	100	100	100	100	100	100	100	100	100	99	99	99
2.21	100	100	100	100	100	100	100	100	99	99	99	99
2.20	100	100	100	100	100	100	100	100	99	99	99	99
2.19	100	100	100	100	100	100	100	100	99	99	99	99
2.18	100	100	100	100	100	100	100	100	99	99	99	99
2.17	100	100	100	100	100	100	100	99	99	99	99	99
2.16	100	100	100	100	100	100	100	99	99	99	99	99
2.15	100	100	100	100	100	100	100	99	99	99	99	99
2.14	100	100	100	100	100	100	100	99	99	99	99	99
2.13	100	100	100	100	100	100	100	99	99	99	99	99
2.12	100	100	100	100	100	100	99	99	99	99	99	99
2.11	100	100	100	100	100	100	99	99	99	99	99	99
2.10	100	100	100	100	100	100	99	99	99	99	99	99
2.09	100	100	100	100	100	100	99	99	99	99	99	99
2.08	100	100	100	100	100	100	99	99	99	99	99	99
2.07	100	100	100	100	100	100	99	99	99	99	99	99
2.06	100	100	100	100	100	99	99	99	99	99	99	99
2.05	100	100	100	100	100	99	99	99	99	99	99	99
2.04	100	100	100	100	100	99	99	99	99	99	99	99
2.03	100	100	100	100	100	99	99	99	99	99	99	99
2.02	100	100	100	100	100	99	99	99	99	99	99	99
2.01	100	100	100	100	100	99	99	99	99	99	99	98
2.00	100	100	100	100	100	99	99	99	99	99	99	98
1.99	100	100	100	100	100	99	99	99	99	99	98	98
1.98	100	100	100	100	99	99	99	99	99	98	98	98
1.97	100	100	100	100	99	99	99	99	99	98	98	98
1.96	100	100	100	100	99	99	99	99	98	98	98	98
1.95	100	100	100	100	99	99	99	99	98	98	98	98
1.94	100	100	100	100	99	99	99	99	98	98	98	98
1.93	100	100	100	100	99	99	99	98	98	98	98	98

Figure 3-13. Quality Index (QI) Values

Quality Index (QI) Values PWL for a given sample size (n)												
1.92	100	100	100	100	99	99	99	98	98	98	98	98
1.91	100	100	100	100	99	99	99	98	98	98	98	98
1.90	100	100	100	100	99	99	98	98	98	98	98	98
1.89	100	100	100	100	99	99	98	98	98	98	98	98
1.88	100	100	100	100	99	99	98	98	98	98	98	98
1.87	100	100	100	99	99	98	98	98	98	98	98	98
1.86	100	100	100	99	99	98	98	98	98	98	98	98
1.85	100	100	100	99	99	98	98	98	98	98	98	98
1.84	100	100	100	99	99	98	98	98	98	98	97	97
1.83	100	100	100	99	99	98	98	98	98	98	97	97
1.82	100	100	100	99	99	98	98	98	98	97	97	97
1.81	100	100	100	99	98	98	98	98	97	97	97	97
1.80	100	100	100	99	98	98	98	98	97	97	97	97
1.79	100	100	100	99	98	98	98	97	97	97	97	97
1.78	100	100	100	99	98	98	98	97	97	97	97	97
1.77	100	100	100	99	98	98	97	97	97	97	97	97
1.76	100	100	100	99	98	98	97	97	97	97	97	97
1.75	100	100	100	99	98	98	97	97	97	97	97	97
1.74	100	100	100	98	98	97	97	97	97	97	97	97
1.73	100	100	100	98	98	97	97	97	97	97	97	97
1.72	100	100	100	98	98	97	97	97	97	97	96	96
1.71	100	100	99	98	97	97	97	97	97	96	96	96
1.70	100	100	99	98	97	97	97	97	96	96	96	96
1.69	100	100	99	98	97	97	97	96	96	96	96	96
1.68	100	100	99	98	97	97	97	96	96	96	96	96
1.67	100	100	99	98	97	97	96	96	96	96	96	96
1.66	100	100	99	98	97	97	96	96	96	96	96	96
1.65	100	100	99	97	97	96	96	96	96	96	96	96
1.64	100	100	99	97	97	96	96	96	96	96	96	96
1.63	100	100	98	97	97	96	96	96	96	96	96	95
1.62	100	100	98	97	96	96	96	96	96	95	95	95
1.61	100	100	98	97	96	96	96	96	95	95	95	95
1.60	100	100	98	97	96	96	96	95	95	95	95	95
1.59	100	100	98	97	96	96	95	95	95	95	95	95
1.58	100	100	98	96	96	96	95	95	95	95	95	95
1.57	100	100	97	96	96	95	95	95	95	95	95	95
1.56	100	100	97	96	96	95	95	95	95	95	95	95
1.55	100	100	97	96	95	95	95	95	95	95	95	95

Quality Index Values (continued)

Quality Index (QI) Values PWL for a given sample size (n)												
QI	**n=3**	**n=4**	**n=5**	**n=6**	**n=7**	**n=8**	**n=9**	**n=10**	**n=11**	**n=12**	**n=13**	**n=14**
1.54	100	100	97	96	95	95	95	95	95	94	94	94
1.53	100	100	97	96	95	95	95	95	94	94	94	94
1.52	100	100	97	96	95	95	95	94	94	94	94	94
1.51	100	100	96	95	95	95	94	94	94	94	94	94
1.50	100	100	96	95	95	94	94	94	94	94	94	94
1.49	100	100	96	95	95	94	94	94	94	94	94	94
1.48	100	99	96	95	94	94	94	94	94	94	94	94
1.47	100	99	96	95	94	94	94	94	94	94	93	93
1.46	100	99	95	94	94	94	94	94	93	93	93	93
1.45	100	98	95	94	94	94	93	93	93	93	93	93
1.44	100	98	95	94	94	93	93	93	93	93	93	93
1.43	100	98	95	94	94	93	93	93	93	93	93	93
1.42	100	97	95	94	93	93	93	93	93	93	93	93
1.41	100	97	94	94	93	93	93	93	93	93	93	93
1.40	100	97	94	93	93	93	93	93	92	92	92	92
1.39	100	96	94	93	93	93	92	92	92	92	92	92
1.38	100	96	94	93	93	92	92	92	92	92	92	92
1.37	100	96	93	93	92	92	92	92	92	92	92	92
1.36	100	95	93	93	92	92	92	92	92	92	92	92
1.35	100	95	93	92	92	92	92	92	92	92	92	92
1.34	100	95	93	92	92	92	92	92	91	91	91	91
1.33	100	94	93	92	92	92	91	91	91	91	91	91
1.32	100	94	92	92	91	91	91	91	91	91	91	91
1.31	100	94	92	92	91	91	91	91	91	91	91	91
1.30	100	93	92	91	91	91	91	91	91	91	91	91
1.29	100	93	92	91	91	91	91	91	91	90	90	90
1.28	100	93	91	91	91	91	90	90	90	90	90	90
1.27	100	92	91	91	90	90	90	90	90	90	90	90
1.26	100	92	91	90	90	90	90	90	90	90	90	90
1.25	100	92	91	90	90	90	90	90	90	90	90	90
1.24	100	91	90	90	90	90	90	90	90	90	90	89
1.23	100	91	90	90	90	89	89	89	89	89	89	89
1.22	100	91	90	89	89	89	89	89	89	89	89	89
1.21	100	90	90	89	89	89	89	89	89	89	89	89
1.20	100	90	89	89	89	89	89	89	89	89	89	89
1.19	100	90	89	89	89	89	89	89	89	88	88	88
1.18	100	89	89	89	88	88	88	88	88	88	88	88
1.17	100	89	88	88	88	88	88	88	88	88	88	88

Quality Index Values (continued)

Quality Index (QI) Values PWL for a given sample size (n)												
QI	**n=3**	**n=4**	**n=5**	**n=6**	**n=7**	**n=8**	**n=9**	**n=10**	**n=11**	**n=12**	**n=13**	**n=14**
1.16	100	89	88	88	88	88	88	88	88	88	88	88
1.15	97	88	88	88	88	88	88	88	88	88	88	88
1.14	95	88	88	88	87	87	87	87	87	87	87	87
1.13	93	88	87	87	87	87	87	87	87	87	87	87
1.12	92	87	87	87	87	87	87	87	87	87	87	87
1.11	91	87	87	87	87	87	87	87	87	87	87	87
1.10	90	87	87	87	87	87	87	87	87	87	86	86
1.09	89	86	86	86	86	86	86	86	86	86	86	86
1.08	88	86	86	86	86	86	86	86	86	86	86	86
1.07	88	86	86	86	86	86	86	86	86	86	86	86
1.06	87	85	85	85	85	86	86	86	86	86	86	86
1.05	86	85	85	85	85	85	85	85	85	85	85	85
1.04	86	85	85	85	85	85	85	85	85	85	85	85
1.03	85	84	85	85	85	85	85	85	85	85	85	85
1.02	84	84	84	84	84	84	85	85	85	85	85	85
1.01	84	84	84	84	84	84	84	84	84	84	84	84
1.00	83	83	84	84	84	84	84	84	84	84	84	84
0.99	83	83	83	84	84	84	84	84	84	84	84	84
0.98	82	83	83	83	83	83	83	84	84	84	84	84
0.97	82	82	83	83	83	83	83	83	83	83	83	83
0.96	81	82	82	83	83	83	83	83	83	83	83	83
0.95	81	82	82	82	83	83	83	83	83	83	83	83
0.94	80	81	82	82	82	82	82	82	82	82	83	83
0.93	80	81	82	82	82	82	82	82	82	82	82	82
0.92	79	81	81	82	82	82	82	82	82	82	82	82
0.91	79	80	81	81	81	81	82	82	82	82	82	82
0.90	78	80	81	81	81	81	81	81	81	81	81	81
0.89	78	80	80	81	81	81	81	81	81	81	81	81
0.88	78	79	80	80	81	81	81	81	81	81	81	81
0.87	77	79	80	80	80	80	80	80	81	81	81	81
0.86	77	79	79	80	80	80	80	80	80	80	80	80
0.85	76	78	79	79	80	80	80	80	80	80	80	80
0.84	76	78	79	79	79	79	80	80	80	80	80	80
0.83	76	78	78	79	79	79	79	79	79	79	79	79
0.82	75	77	78	79	79	79	79	79	79	79	79	79
0.81	75	77	78	78	78	79	79	79	79	79	79	79
0.80	74	77	77	78	78	78	78	78	78	79	79	79
0.79	74	76	77	78	78	78	78	78	78	78	78	78
0.78	74	76	77	77	77	78	78	78	78	78	78	78
0.77	73	76	77	77	77	77	77	78	78	78	78	78
0.76	73	75	76	77	77	77	77	77	77	77	77	77

Quality Index Values (continued)

Quality Index (QI) Values PWL for a given sample size (n)												
QI	**n=3**	**n=4**	**n=5**	**n=6**	**n=7**	**n=8**	**n=9**	**n=10**	**n=11**	**n=12**	**n=13**	**n=14**
0.75	73	75	76	76	77	77	77	77	77	77	77	77
0.74	72	75	76	76	76	76	77	77	77	77	77	77
0.73	72	74	75	76	76	76	76	76	76	76	76	76
0.72	71	74	75	75	76	76	76	76	76	76	76	76
0.71	71	74	75	75	75	75	76	76	76	76	76	76
0.70	71	73	74	75	75	75	75	75	75	75	75	76
0.69	70	73	74	74	75	75	75	75	75	75	75	75
0.68	70	73	74	74	74	74	75	75	75	75	75	75
0.67	70	72	73	74	74	74	74	74	74	74	75	75
0.66	69	72	73	73	74	74	74	74	74	74	74	74
0.65	69	72	73	73	73	74	74	74	74	74	74	74
0.64	69	71	72	73	73	73	73	73	73	74	74	74
0.63	68	71	72	72	73	73	73	73	73	73	73	73
0.62	68	71	72	72	72	73	73	73	73	73	73	73
0.61	68	70	71	72	72	72	72	72	72	73	73	73
0.60	67	70	71	71	72	72	72	72	72	72	72	72
0.59	67	70	71	71	71	72	72	72	72	72	72	72
0.58	67	69	70	71	71	71	71	71	71	72	72	72
0.57	66	69	70	70	71	71	71	71	71	71	71	71
0.56	66	69	70	70	70	71	71	71	71	71	71	71
0.55	66	68	69	70	70	70	70	70	70	70	71	71
0.54	65	68	69	69	70	70	70	70	70	70	70	70
0.53	65	68	69	69	69	69	70	70	70	70	70	70
0.52	65	67	68	69	69	69	69	69	69	69	69	70
0.51	65	67	68	68	69	69	69	69	69	69	69	69
0.50	64	67	68	68	68	68	69	69	69	69	69	69
0.49	64	66	67	68	68	68	68	68	68	68	68	68
0.48	64	66	67	67	68	68	68	68	68	68	68	68
0.47	63	66	67	67	67	67	67	68	68	68	68	68
0.46	63	65	66	67	67	67	67	67	67	67	67	67
0.45	63	65	66	66	67	67	67	67	67	67	67	67
0.44	62	65	65	66	66	66	66	67	67	67	67	67
0.43	62	64	65	66	66	66	66	66	66	66	66	66
0.42	62	64	65	65	65	66	66	66	66	66	66	66
0.41	62	64	64	65	65	65	65	65	65	66	66	66
0.40	61	63	64	65	65	65	65	65	65	65	65	65
0.39	61	63	64	64	64	65	65	65	65	65	65	65
0.38	61	63	63	64	64	64	64	64	64	64	64	65

Quality Index Values (continued)

Quality Index (QI) Values PWL for a given sample size (n)												
QI	**n=3**	**n=4**	**n=5**	**n=6**	**n=7**	**n=8**	**n=9**	**n=10**	**n=11**	**n=12**	**n=13**	**n=14**
0.37	60	62	63	63	64	64	64	64	64	64	64	64
0.36	60	62	63	63	63	63	64	64	64	64	64	64
0.35	60	62	62	63	63	63	63	63	63	63	63	63
0.34	60	61	62	62	63	63	63	63	63	63	63	63
0.33	59	61	62	62	62	62	62	63	63	63	63	63
0.32	59	61	61	62	62	62	62	62	62	62	62	62
0.31	59	60	61	61	61	62	62	62	62	62	62	62
0.30	58	60	61	61	61	61	61	61	61	61	62	62
0.29	58	60	60	61	61	61	61	61	61	61	61	61
0.28	58	59	60	60	60	61	61	61	61	61	61	61
0.27	58	59	60	60	60	60	60	60	60	60	60	60
0.26	57	59	59	60	60	60	60	60	60	60	60	60
0.25	57	58	59	59	59	59	59	60	60	60	60	60
0.16	54	55	56	56	56	56	56	56	56	56	56	56
0.15	54	55	55	56	56	56	56	56	56	56	56	56
0.14	54	55	55	55	55	55	55	55	55	55	55	55
0.13	54	54	55	55	55	55	55	55	55	55	55	55
0.12	53	54	54	54	54	55	55	55	55	55	55	55
0.11	53	54	54	54	54	54	54	54	54	54	54	54
0.10	53	53	54	54	54	54	54	54	54	54	54	54
0.09	52	53	53	53	53	53	53	53	53	53	53	54
0.08	52	53	53	53	53	53	53	53	53	53	53	53
0.07	52	52	52	53	53	53	53	53	53	53	53	53
0.06	52	52	52	52	52	52	52	52	52	52	52	52
0.05	51	52	52	52	52	52	52	52	52	52	52	52
0.04	51	51	51	51	51	52	52	52	52	52	52	52
0.03	51	51	51	51	51	51	51	51	51	51	51	51
0.02	51	51	51	51	51	51	51	51	51	51	51	51
0.01	50	50	50	50	50	50	50	50	50	50	50	50
0.00	50	50	50	50	50	50	50	50	50	50	50	50
-0.01	50	50	50	50	50	50	50	50	50	50	50	50
-0.02	49	49	49	49	49	49	49	49	49	49	49	49
-0.03	49	49	49	49	49	49	49	49	49	49	49	49
-0.04	49	49	49	49	49	48	48	48	48	48	48	48
-0.05	49	48	48	48	48	48	48	48	48	48	48	48
-0.06	48	48	48	48	48	48	48	48	48	48	48	48
-0.07	48	48	48	47	47	47	47	47	47	47	47	47
-0.08	48	47	47	47	47	47	47	47	47	47	47	47
-0.09	48	47	47	47	47	47	47	47	47	47	47	46
-0.10	47	47	46	46	46	46	46	46	46	46	46	46

Quality Index Values (continued)

Quality Index (QI) Values PWL for a given sample size (n)												
QI	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10	n=11	n=12	n=13	n=14
-0.11	47	46	46	46	46	46	46	46	46	46	46	46
-0.12	47	46	46	46	46	45	45	45	45	45	45	45
-0.13	46	46	45	45	45	45	45	45	45	45	45	45
-0.14	46	45	45	45	45	45	45	45	45	45	45	45
-0.15	46	45	45	44	44	44	44	44	44	44	44	44
-0.16	46	45	44	44	44	44	44	44	44	44	44	44
-0.17	45	44	44	44	44	44	44	43	43	43	43	43
-0.18	45	44	44	43	43	43	43	43	43	43	43	43
-0.19	45	44	43	43	43	43	43	43	43	43	43	43
-0.20	44	43	43	43	43	42	42	42	42	42	42	42
-0.21	44	43	43	42	42	42	42	42	42	42	42	42
-0.22	44	43	42	42	42	42	42	42	42	42	42	
-0.23	44	42	42	42								
-0.24	43	42										
-0.25	43	42										
-0.26	43											
-0.27	42											
-0.28	42											
-0.29	42											
-0.30	42											

Quality Index Values (continued)

Pay Factors

Pay factors (PF) are calculated for the binder content, air voids at N_{des}, VMA at N_{des}, and in-place density (% Gmm). The appropriate pay factor for each property is calculated as follows:

<u>Estimated PWL > 90</u>

$$\text{Pay Factor} = (105.00 - 0.50 \times (100.00 - \text{PWL})/100$$

<u>Estimated PWL ≥ 50 and ≤ 90</u>

$$\text{Pay Factor} = (100.00 - 0.000020072 \times (100.00 - \text{PWL})^{3.5877})/100$$

Binder content, air voids, VMA, and in-place density PF values are reported to the nearest 0.01.

If the Lot PWL for any one of the properties is less than 50 or a sublot has an air void content less than 1.0 %, the lot is referred to the Office of Materials Management as a failed material.

A composite pay factor for each lot based on the mixture properties and density is determined by a weighted formula as follows:

$$\text{Lot Pay Factor} = 0.20\,(PF_{BINDER}) + 0.35\,(PF_{VOIDS}) + 0.10\,(PF_{VMA}) + 0.35\,(PF_{DENSITY})$$

where:

Lot PF = Lot Composite Pay Factor for Mixture and Density
PF_{BINDER} = Lot Pay Factor for Binder Content
PF_{VOIDS} = Lot Pay Factor for Air Vois at N_{des}
PF_{VMA} = Lot Pay Factor for VMA at N_{des}
$PF_{DENSITY}$ = Lot Pay Factor for In-Place Density (%Gmm)

ADJUSTMENT QUANTITY -- QC/QA HMA ≥ 1 Lot

The pay factors are used to calculate a quality assurance adjustment quantity (q) for the lot. The adjustment for mixture properties and density is calculated as follows:

$$q = L \times U \times (\text{Lot PF} - 1.00)/\text{MAF}$$

where:

q = quality assurance adjustment for mixture properties and density of the lot
L = Lot quantity
U = Unit price for the material, $/Ton
Lot PF = Lot Pay Factor

The following example indicates how the Pay Factors and the Qualiity Assurance Adjustment for PWL are determined for QC/QA mixtures ≥ 1 Lot:

Example:

19.0 mm Intermediate

Sublot 1 = 1000 tons
Sublot 2 = 1000 tons
Sublot 3 = 1000 tons
Sublot 4 = 1000 tons
Sublot 5 = 1000 tons

Unit Price = $40.00/ton

MAF = 1.000

<u>JMF</u> % Binder = 5.0 %
Air Voids = 4.0 %
VMA = 13.5 %

	Sublot 1	Sublot 2	Sublot 3	Sublot 4	Sublot 5
% Binder	4.80	4.90	5.20	5.20	5.30
Air Voids	3.80	3.50	3.20	4.70	4.60
VMA	13.80	13.90	12.60	12.80	13.70
Density (%MSG)	91.10	91.70	92.30	92.90	92.50

<u>% Binder</u>

$$\bar{x} = \frac{4.80 + 4.90 + 5.20 + 5.20 + 5.30}{5} = 5.08$$

s = 0.22

USL = + 0.40 from JMF = 0.40 + 5.0 = 5.40

$$Q_U = \frac{\text{USL} - \bar{x}}{s} = \frac{5.40 - 5.08}{0.22} = 1.45$$

From Figure 5-10 for n = 5 the PWL_U is 95

LSL = - 0.40 from JMF = 5.0 – 0.40 = 4.60

$$Q_L = \frac{\bar{x} - LSL}{s} = \frac{5.08 - 4.60}{0.22} = 2.18$$

From Figure 3-13 for n = 5 the PWL_L is 100

Total PWL = (PWL_U + PWL_L) – 100 = (95 + 100) – 100 = 95

Pay Factor (Estimated PWL > 90) = (105.00 – 0.50 x (100.00 – PWL)/100

= (105.00 – 0.50 x (100.00 – 95)/100

= (105.00 – 2.50)/100 = 1.03

Pay Factors for the Air Voids, VMA, and Density are indicated in Figure 3-14 and are as follows:

Pay Factor (Air Voids) = 1.05

Pay Factor (VMA) = 1.02

Paty Factor (Density) = 1.04

Lot Pay Factor = 0.20 (PF_{BINDER}) + 0.35 (PF_{VOIDS}) + 0.10 (PF_{VMA}) + 0.35 ($PF_{DENSITY}$)

= 0.20 (1.03) + 0.35 (1.05) + 0.10 (1.02) + 0.35 (1.04)

= 0.21 + 0.37 + 0.10 + 0.36 = 1.04

The Quality Assurance Adjustment for the Lot is calculated as follows:

Quality Assurance Adjustment ($) = L x U x (Lot PF – 1.00)/MAF

L = Lot quantity
U = Unit Price for Material, $/Ton
Lot PF = Lot Pay Factor

Quality Assurance Adjustment = 5000 x $40.00 x (1.04 – 1.00)/1.000

= + $8000.00

INDIANA DEPARTMENT OF TRANSPORTATION

HOT MIX ASPHALT ANALYSIS FOR QUALITY ASSURANCE

CONTRACT NO. ____________ PLANT NO. __________ LOT NO. ______ DATE ___________

MIXTURE _________________________________ DMF/JMF NO. _________________________

Mixture & Density	$\bar{x}$	s	Qu			Q_L			Total PWL
			USL	$Q_U = \frac{USL - \bar{x}}{s}$	PWL_U	LSL	$Q_L = \frac{\bar{x} - LSL}{s}$	PWL_L	
% Binder	5.08	0.22	5.40	1.45	95	4.60	2.18	100	95
Air Voids	3.96	0.67	5.40	2.15	100	2.60	2.03	100	100
VMA	13.36	0.61	14.70	2.20	100	12.50	1.41	94	94
Density (% MSG)	92.10	0.71				91.00	1.55	97	97

* Requires submittal to the Office of Materials Management for Failed Material Investigation

Binder		Air Voids		VMA		Density		Lot Pay Factor	Quality Assurance Adjustment
Pay Factor	0.20xPF	Pay Factor	0.35xPF	Pay Factor	0.10xPF	Pay Factor	0.35xPF		
1.03	0.21	1.05	0.37	1.02	0.10	1.04	0.36	1.04	+ $8000

<u>Estimated PWL > 90</u>

Pay Factor = (105.00 – 0.50 x (100.00 – PWL)/100

<u>Estimated PWL ≥ 50 and ≤ 90</u>

Pay Factor = $(100.00 - 0.000020072 \times (100.00 - PWL)^{3.5877})/100$

Lot Pay Factor = $0.20\,(PF_{BINDER}) + 0.35\,(PF_{VOIDS}) + 0.10\,(PF_{VMA}) + 0.35\,(PF_{DENSITY})$

Quality Assurance Adjustment ($) = L x U x (Lot PF – 1.00)/MAF

L = Lot quantity
U = Unit Price for Material, $/Ton
Lot PF = Lot Pay Factor

Figure 3-14. Quality Assurance Adjustment

PAY FACTORS -- QC/QA HMA (Dense Graded Mixture < 1 Lot and Open Graded Mixtures)

After the tests are conducted, the test data is evaluated for compliance with the Specifications. CAA and temperature tests are taken in accordance with standard procedures and recorded. For open graded mixtures, lot numbers begin with number 1 for each type of mixture and are continuous for the entire contract regardless of the number of adjustment periods for that type of mixture.

When the required tests for one sublot are completed, the difference between the test values and the required value on the JMF is determined and pay factors calculated. For mixtures produced during the adjustment period, pay factors based on the JMF are used. A composite pay factor for each sublot is determined for the binder content, air voids @ N_{des}, VMA @ N_{des}, and density of the mixture as follows:

$$SCPF = 0.20(PF_{BINDER}) + 0.35(PF_{VOIDS}) + 0.10(PF_{VMA}) + 0.35(PF_{DENSITY})$$

where:

SCPF	=	Sublot Composite Pay Factor for Mixture and Density
PF_{BINDER}	=	Sublot Pay Factor for Binder Content
PF_{VOIDS}	=	Sublot Pay Factor for Air Voids at N_{des}
PF_{VMA}	=	Sublot Pay Factor for VMA at N_{des}
$PF_{DENSITY}$	=	Sublot Pay Factor for Density

If the SCPF for a sublot is less than 0.85, the pavement is evaluated by INDOT. If the Contractor is not required to remove the mixture, quality assurance adjustments of the sublot are assessed or other corrective actions taken as determined by INDOT.

MIXTURE

Sublot test results for mixture properties are assigned pay factors in accordance with the following:

BINDER CONTENT		
DENSE GRADED Deviation from JMF (±%)	**OPEN GRADED Deviation from JMF (±%)**	**PAY FACTOR**
≤ 0.2	≤ 0.2	1.05
0.3	0.3	1.04
0.4	0.4	1.02
0.5	0.5	1.00
0.6	0.6	0.90
0.7	0.7	0.80
0.8	0.8	0.60
0.9	0.9	0.30
1.0	1.0	0.00
> 1.0	> 1.0	Submit to the Office of Materials Management*

* Test results are considered and adjudicated as a failed material in accordance with normal INDOT practice as listed in 105.03.

AIR VOIDS		
DENSE GRADED Deviation from JMF (±%)	**OPEN GRADED Deviation from JMF (±%)**	**PAY FACTOR**
≤ 0.5	≤ 1.0	1.05
> 0.5 and ≤ 1.0	> 1.0 and ≤ 3.0	1.00
1.1	3.1	0.98
1.2	3.2	0.96
1.3	3.3	0.94
1.4	3.4	0.92
1.5	3.5	0.90
1.6	3.6	0.84
1.7	3.7	0.78
1.8	3.8	0.72
1.9	3.9	0.66
2.0	4.0	0.60
> 2.0	> 4.0	Submit to the Office of Materials Management*

* Test results are considered and adjudicated as a failed material in accordance with normal INDOT practice as listed in 105.03.

VMA		
DENSE GRADED Deviation from JMF (±%)	**OPEN GRADED Deviation from JMF (±%)**	**PAY FACTOR**
≤ 0.5		1.05
> 0.5 and ≤ 1.0	All	1.00
> 1.0 and ≤ 1.5		0.90
> 1.5 and ≤ 2.0		0.70
> 2.0 and ≤ 2.5		0.30
> 2.5		Submit to the Office of Materials Management*

* Test results are considered and adjudicated as a failed material in accordance with normal INDOT practice as listed in 105.03.

DENSITY

Sublot test results for density are assigned pay factors in accordance with the following:

DENSITY		
Percentages based on % MSG	**Pay Factors – Percent**	
Dense Graded	Open Graded	
≥ 97.0		Submitted to the Office of Materials Management*
95.6 - 96.9		1.05 - 0.01 for each 0.1% above 95.5
94.0 - 95.5		1.05
93.1 - 93.9		1.00 + 0.005 for each 0.1% above 93.0
92.0 - 93.0	84.0	1.00
91.0 - 91.9		1.00 - 0.005 for each 0.1% below 92.0
90.0 - 90.9		0.95 - 0.010 for each 0.1% below 91.0
89.0 - 89.9		0.85 - 0.030 for each 0.1% below 90.0
≤ 88.9		Submitted to the Office of Materials Management*

* Test results are considered and adjudicated as a failed material in accordance with normal INDOT practice as listed in 105.03.

Figure 3-15 indicates the density pay factors required for the % Maximum Specific Gravity of the cores.

DENSITY -- DENSE GRADED							
% MSG	Pay Factor	% MSG	Pay Factor	% MSG	Pay Factor	% MSG	Pay Factor
≥97.0	*	94.9	1.05	92.8	1.00	90.7	0.92
96.9	0.91	94.8	1.05	92.7	1.00	90.6	0.91
96.8	0.92	94.7	1.05	92.6	1.00	90.5	0.90
96.7	0.93	94.6	1.05	92.5	1.00	90.4	0.89
96.6	0.94	94.5	1.05	92.4	1.00	90.3	0.88
96.5	0.95	94.4	1.05	92.3	1.00	90.2	0.87
96.4	0.96	94.3	1.05	92.2	1.00	90.1	0.86
96.3	0.97	94.2	1.05	92.1	1.00	90.0	0.85
96.2	0.98	94.1	1.05	92.0	1.00	89.9	0.82
96.1	0.99	94.0	1.05	91.9	1.00	89.8	0.79
96.0	1.00	93.9	1.05	91.8	0.99	89.7	0.76
95.9	1.01	93.8	1.04	91.7	0.99	89.6	0.73
95.8	1.02	93.7	1.04	91.6	0.98	89.5	0.70
95.7	1.03	93.6	1.03	91.5	0.98	89.4	0.67
95.6	1.04	93.5	1.03	91.4	0.97	89.3	0.64
95.5	1.05	93.4	1.02	91.3	0.97	89.2	0.61
95.4	1.05	93.3	1.02	91.2	0.96	89.1	0.58
95.3	1.05	93.2	1.01	91.1	0.96	89.0	0.55
95.2	1.05	93.1	1.01	91.0	0.95	88.9	*
95.1	1.05	93.0	1.00	90.9	0.94		
95.0	1.05	92.9	1.00	90.8	0.93		
DENSITY -- OPEN GRADED							
84.0 -- 1.00							

* Requires submittal to Office of Materials Management for Failed Material Investigation

Figure 3-15. Density Pay Factors

ADJUSTMENT QUANTITY -- QC/QA HMA < 1 Lot and Open Graded Mixtures

The pay factors are used to calculate a quality assurance adjustment quantity (q) for the sublot. The adjustment for mixture properties and density is calculated as follows:

$$q = L \times U \times (SCPF - 1.00)/MAF$$

where:

q	= quality assurance adjustment for the sublot
L	= Sublot quantity
U	= Unit price for the material, $/Ton
SCPF	= Sublot composite pay factor

The following example indicates how Quality Assurance Adjustments are determined for QC/QA mixtures < 1 Lot and Open Graded mixtures:

Example:

25.0 mm Base

Sublot 1 = 1000 tons
Sublot 2 = 1000 tons
Sublot 3 = 1000 tons
Sublot 4 = 1000 tons

Unit Price = $28.00/ton

MAF = 1.000

JMF % Binder = 4.2 %
Air Voids = 4.0 %
VMA = 12.5 %

	Sublot 1	Sublot 2	Sublot 3	Sublot 4
% Binder	4.5	4.6	4.8	4.2
Air Voids	3.8	3.7	3.2	4.7
VMA	12.2	12.1	11.6	13.4
Density (%MSG)	91.1	90.7	89.9	92.9

Deviations for JMF % Binder, Air Voids, and VMA:

	Sublot 1	Sublot 2	Sublot 3	Sublot 4
% Binder	0.3	0.4	0.6	0.2
Air Voids	0.2	0.3	0.8	0.7
VMA	0.3	0.4	0.9	0.9

Using the pay factor charts, the following values are obtained:

	Sublot 1	Sublot 2	Sublot 3	Sublot 4
% Binder	1.04	1.02	0.90	1.05
Air Voids	1.05	1.05	1.00	1.00
VMA	1.05	1.05	1.00	1.00
Density (%MSG)	0.96	0.92	0.82	1.00

Calculations to determine the Quality Assurance Adjustment are indicated in Figure 3-16.

INDIANA DEPARTMENT OF TRANSPORTATION
HOT MIX ASPHALT ANALYSIS FOR QUALITY ASSURANCE

CONTRACT NO. _______________ PLANT NO. _________ LOT NO. __________ DATE ____________

MIXTURE ____ DMF/JMF NO. ____________________

Mixture & Density	SUBLOT 1			SUBLOT 2			SUBLOT 3			SUBLOT 4		
	Pay Factor	Mult		Pay Factor	Mult		Pay Factor	Mult.		Pay Factor	Mult.	
% Binder	1.04	0.20	0.2080	1.02	0.20	0.2040	0.90	0.20	0.1800	1.05	0.20	0.2100
Air Voids	1.05	0.35	0.3675	1.05	0.35	0.3675	1.00	0.35	0.3500	1.00	0.35	0.3500
VMA	1.05	0.10	0.1050	1.05	0.10	0.1050	1.00	0.10	0.1000	1.00	0.10	0.1000
Density	0.96	0.35	0.3360	0.92	0.35	0.3220	0.82	0.35	0.2870	1.00	0.35	0.3500
SCPF			1.02			1.00			0.92			1.01

* Requires submittal to the Materials and Tests Division for Failed Material Investigation

QUALITY ASSURANCE ADJUSTMENTS							
Sublot 1 Quantity L (tons)	Sublot 1 Adjustment ($)	Sublot 2 Quantity L (tons)	Sublot 2 Adjustment ($)	Sublot 3 Quantity L (tons)	Sublot 3 Adjustment ($)	Sublot 4 Quantity L (tons)	Sublot 4 Adjustment ($)
1000	+560	1000	0	1000	-2240	1000	+280

U = Unit Price for Material, $/Ton

Quality Assurance Adjustment = L x U x (SCPF – 1.00) / MAF

Figure 3-16. Quality Assurance Adjustment

MIX APPEAL -- QC/QA HMA

If the Producer does not agree with the acceptance test results, a request may be submitted in writing that additional samples be tested. The written request is required to include the Producer's test results and be made within seven calendar days of receipt of the written results of the HMA tests for that lot. The appeal is not accepted if the Producer has not conducted any tests that indicate a higher Pay Factor than was determined from the test results by INDOT.

Additional tests for the appeal may be requested for the maximum specific gravity, bulk specific gravity of the gyratory specimens, binder content, or bulk specific gravity of the density cores. One or more of these tests may be requested for the sublot or entire lot. Upon approval of the appeal, the backup samples are tested as follows:

1) Maximum Specific Gravity -- The sample is dried in accordance with **ITM 572** and mass determined in water in accordance with **AASHTO T 209**.

2) Bulk Specific Gravity of the Gyratory Specimens -- New gyratory specimens are prepared and tested in accordance with **AASHTO T 312**.

3) Binder Content -- The binder content is tested in accordance with the test method that was used for acceptance or as directed by INDOT.

4) Bulk Specific Gravity of the Density Core -- Additional cores are taken within seven calendar days unless otherwise directed. The core locations are determined by adding 1.0 ft longitudinally of the cores tested for acceptance using the same transverse offset. The cores are dried in accordance with ITM 572 and tested in accordance with **AASHTO T 166**, Method A.

The appeal results replace all previous test result(s) for acceptance of the mixture properties and density.

SMOOTHNESS

Smoothness of HMA pavements is measured using a profilograph (Figure 3-17), and a profile index for a section of pavement is obtained from a profilogram recorded by the profilograph.

Figure 3-17. Profilograph

PROCEDURES

The procedures for the operation of the profilograph are as follows:

1) The profilograph is operated by a Contractor Technician monitored by a Department Qualified Technician.

2) The profilograph is required to be certified and calibrated in accordance with **ITM 912.**

3) The certificate of compliance is required to be presented to the Engineer prior to use of the profilograph on the contract.

4) The profilograph is checked by the Engineer to verify that the band width, bump height, low pass filter, and the short segment settings on the profilograph and the tire pressure correspond with the requirements indicated on the certificate of compliance.

5) The profilograph is operated in an area safe from traffic hazards, protected by traffic control, and in an area approved by the Engineer.

6) The profilograph is operated in accordance with the manufacturer operating instructions.

7) The profilograph is operated manually at speeds less than or equal to 4 mph (6.7 kph).

8) Prior to the operation of the profilograph, the operator is required to enter the following information into the profilograph.

   a) Company
   b) Operator
   c) Contract Number
   d) Route
   e) Lane
   f) Lane Direction
   g) Collection Time and Date
   h) Pavement Course (Surface, Intermediate or Base)
   i) Pavement Type (HMA)
   j) English or Metric Measurement

9) For lanes less than or equal to 12 ft (3.6 m) wide, the profilograph is operated in the direction of traffic and 3.0 ± 0.5 ft (0.9144 ± 0.152 m) from and parallel to the right edge of the lane. If the lane may be utilized by traffic in either direction, the profilograph is operated in the direction of increasing station numbers and 3.0 ± 0.5 ft (0.9144 ± 0.152 m) from and parallel to the right edge of the lane.

10) For lanes greater than 12 ft (3.6 m) wide, the profilograph is operated in the direction of traffic and 3.0 ± 0.5 ft (0.9144 ± 0.152 m) from and parallel to both the left and the right edge of each lane. If the lane may be utilized by traffic in either direction, the profilograph is operated in the direction of increasing stations and 3.0 ± 0.5 ft (0.9144 ± 0.152 m) from and parallel to both the left and the right edge of each lane

11) The Contractor is required to provide the profilogram to the Department Qualified Technician at the completion of each trace. The Qualified Technician signs and dates each trace at the time of receipt.

PROFILOGRAPH EXEMPTIONS

Areas that are exempt from profilograph measurement are:

1) The first and last 50 ft (15.24 m) within the paving limits

2) From 50 ft (15.24 m) before through 50 ft (15.24 m) after each paving exception

3) From 50 ft (15.24 m) before through 50 ft (15.24 m) after each curve with a centerline radius of less than 75 ft (23 m)

4) Vertical curves that exceed the 2 1/2 in. vertical scale measuring capacity of the profilograph

5) From 50 ft (15.24 m) before through 50 ft (15.24 m) after each at-grade railroad crossing

6) From 50 ft (15.24 m) before through 50 ft (15.24 m) after each casting located within 1.0 ft (0.30 m) measured laterally from the required location for profilograph operation. The tolerances indicated for the location of the profilograph operation are excluded.

If more than one trace is required, the profile index is the average of the two traces. Partial sections that occur at the end of a run or prior to an area exempt from measurement are prorated as follows:

1) If the length of the partial section is less than 250 ft, the profile index calculation for the section is averaged into the previous 0.1 mile section.

2) If the length of the partial section is equal to or greater than 250 ft, the profile index calculation for the section is prorated to a 0.1 mile section.

QUALITY ASSURANCE ADJUSTMENTS

A quality assurance adjustment is applied for each 0.1 mi. (0.16 km) section of each lane and the the adjustment is applied to all QC/QA HMA pay items within the pavement section. The adjustment for each section is calculated as follows:

$$q_s = (PF_s - 1.00) \sum_{i=1}^{n} \left(A \times \frac{S}{T} \times U \right)$$

where:

q_s = quality assurance adjustments for smoothness for 1 section
PF_s = pay factor for smoothness
N = number of layers
A = area of section, sq yd (m^2)
S = planned spread rate for material. lb/sq yd (kg/m^2)
T = conversion factor: 2,000 lb/ton (1,000 kg/Mg)
U = unit price for the material, $/ton ($/Mg)

The quality assurance adjustment for smoothness, Qs, for the contract is the total of the quality assurance adjustnments, q_s, on each section calculated by the following formula:

$$Qs = \sum q_s$$

Payment adjustments are made based on a zero blanking band on the final profile index in accordance with the following table. Regardless of the tabulated value, the maximum pay factor for a smoothness section where corrective action has been performed is 1.00.

PAY FACTORS FOR SMOOTHNESS (PI0.0) ZERO BLANKING BAND	
Design Speed Graeter than 45 mph (70 km/h)	
Profile Index in. / 0.1 mi. (mm per 0.16 km)	Pay Factor, PF_s
Over 0.00 to 1.20 in. (Over 0 to 30 mm)	1.06
Over 1.20 to 1.40 in. (Over 30 to 35 mm)	1.05
Over 1.40 to 1.60 in. (Over 35 to 40 mm)	1.04
Over 1.60 to 1.80 in. (Over 40 to 45 mm)	1.03
Over 1.80 to 2.00 in. (Over 45 to 50 mm)	1.02
Over 2.00 to 2.40 in. (Over 50 to 60 mm)	1.01
Over 2.40 to 3.20 in. (Over 60 to 80 mm)	1.00
Over 3.20 to 3.40 in. (Over 80 to 85 mm)	0.96
All pavement with a profile index (PI0.0) greater than 3.40 in. (85 mm) shall be corrected to a profile index less than or equal to 3.40 in. (85 mm).	